Interaction of the Jet of the Most Powerful Radio Galaxy RC J0311+0507 at z=4.514 with the Environment

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Abstract. A significant difference was found between the coordinates of the host galaxy of the superpowerful radio source RC J0311+0507 (z=4.514), determined on the R-filter frames and on the IR-range frames. The reason for this descipancy in coordinates is possibly explained by manifestation of the jet-driven AGN feedback.

Keywords: radio continuum: general; galaxies: nuclei

DOI:10.26119/978-5-6045062-0-2_2020_464

The unique radio galaxy RC J0311+0507 or 4C+04.11 is the most distant (z=4.514) among discovered ones in the Big Trio project (Parijskij et al. 1995; Kopylov et al. 1995, 2006). The radio source maps with high angular resolution (35–150 mas), obtained with the VLBI instruments MERLIN and EVN (Parijskij et al. 2014), show the complex source structure with 8 small-sized features, with total size of the radio source $\approx$ 2.8". The detail with the flattest radio spectrum is the northern component of the nuclear part of the radio source, whose position is determined with accuracy of 2 mas. Note, coordinates of the component, which is the base of the jet, points the nearest position to the host galaxy center.

Deep images of the host galaxy were obtained on the telescopes BTA (6-m) and UKIRT (3.8-m) and also we used archival data of Subaru (8-m) and Spitzer telescopes. The shape and size of the host galaxy on frames differ from filter to filter. The image in the NL671 filter falls exactly on $Ly\alpha$ wavelength at z=4.514. The host has a maximum angular size $\sim 9.5''$ precisely in the filter NL671. This gives an estimate of the $Ly\alpha$-envelope size more then 60 kpc. For comparison, on the Spitzer 3.6μ-band image the host size is $\sim$ 6" (40 kpc).

Astrometric calibrations of 11 frames in different bands were carried out using 6 SDSS objects near the radio source. The accuracy of the SDSS catalog coordinates is $0.1''$. After calibration and measurement of coordinates of the reference objects at each frame we have calculated the mean for the following quantities: $\Delta RA = RA_{sdss} - RA$ and $\Delta Dec = Dec_{sdss} - Dec$, which show accuracy of calibration: $\overline{\Delta RA} = -0.01'' \pm 0.02''$ and $\overline{\Delta Dec} = -0.11'' \pm 0.12''$. Coordinate calibration of the frames turned out to be no worse than the coordinate accuracy of the reference catalog.

The galaxy in the I-band frame is elongated along the radio source and perperdicular to him in the NL671-image, which differs from its view in other bands, where it has a more round shape. For this reason, we excluded the object coordinates obtained in I and NL671 filters from the comparison. Also we took for comparision coordinates of the host galaxy on frames with small differences between catalog and measured coordinates of the SDSS reference objects. So we selected the next frames - R (BTA), K (UKIRT), 4.5μ (Spitzer) and R (Subaru). The coordinates of the host galaxy in these frames are given in Table 1. The asterisk marks those frames where the coordinates were corrected for a slight shift of the coordinate reference relative to the reference catalog. Coordinates of

Table 1. Positions of the radio galaxy RC J0311+0507 host in different bands

Telescope	Band	$R.A._{2000}$	$Dec._{2000}$	$Err_{RA}('')$	$Err_{Dec}('')$
BTA	R*	03:11:47.977	+05:08:03.39	0.10	0.10
Subaru	R*	03:11:47.966	+05:08:03.45	0.07	0.05
UKIRT	K	03:11:47.963	+05:08:03.87	0.05	0.06
Spitzer	$4.5\mu^*$	03:11:47.967	+05:08:03.85	0.07	0.13
EVN	1.7 GHz	03:11:47.966	+05:08:03.87	0.002	0.002

the galaxy in the K and 4.5μ bands are spaced apart from each other by $0.13''$, in the R-band for Subaru and BTA telescopes - by $0.08''$. The coordinates in the IR bands and in the R filter differ by $0.44''$. Coordinates of the galaxy in the IR-bands differ from the location of the jet base by $0.07''$ (K) and $0.08''$ (4.5μ), and in the R filter - by $0.42'' - 0.44''$ and are aligned with the southern part of the jet. The last difference is slightly above the 3σ confidence interval.

The R-band and narrow filters SED665 and NL671 show the look of the host galaxy in the $Ly\alpha$-line at z = 4.514. The coordinates of the host galaxy in these frames are the location of the $Ly\alpha$-envelope center. The frame in the K band probably shows a view of the galaxy's young stellar population at 300-

400 nm, while the Spitzer bands show an old population at 650-820 nm. It can be assumed that this obtained by us coordinate difference is explained by the manifestation of the interaction of the jet with galactic matter.

Acknowledgements. This work was partially supported by the RFBR grant N 17-07-01367. Observations with the SAO RAS telescopes are supported by the Ministry of Science and Higher Education of the Russian Federation. Based [in part] on data collected at Subaru Telescope, which is operated by the NAOJ. This research has made use of the NASA/IPAC Infrared Science Archive, which is funded by the NASA and operated by the California Institute of Technology.

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